Forecasting Reduced Visibilities Due to Atmospheric Aerosols

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Forecasting Reduced Visibilities Due to Atmospheric Aerosols

In recent years the problem of forecasting low visibilities in
inversion dominated regimes has become less a problem of forecasting
restrictions owing to condensed water droplets (fog) but rather has
become more a problem of forecasting low visibilities owing to
suspended particles (pollution, haze, etc.). We are concerned more
today with forecasting low visibilities prior to condensation. The
following quote from Kasten [1] describes the process with which we
are concerned:

> "Before the onset of fog formation, the so-called phase
> of pre-condensation is indicated by increasing humidity and
> decreasing visibility. With rising humidity, the aerosol
> particles are more and more soaked with water from the sur-
> rounding humid air and swell. The increase in particle
> size reduces the visibility. Quantitatively, the variation
> of size distribution of the aerosol particles has to be
> taken into account."

Based on the observational work of Winkler [2] a relationship
between particle radius and relative humidity was determined. From
this relationship a formula was derived which enables one to calculate
the visibility (V) at the forecast relative humidity (f) when the
visibility (V_o) at the present relative humidity (f_o) is known
(Kasten, [1]).

This formula is (assuming an "average" aerosol):

$$\frac{V}{V_o} = \left(\frac{100 - r}{100 - r_o}\right)^{1.3}$$

Figure 1 is a graphical rendering of this formula. Suppose we have at forecast time a certain visibility and relative humidity, say 2.5 nmi and 85% respectively. This graph enables us to determine the visibility at some later time given that we are able to forecast the relative humidity, say 95%. Entering our numerical example on the graph; we begin at the value of 95% on the abscissa (the axis representing the forecast relative humidity), proceed vertically until the sloping line labeled 85% (the initial relative humidity) is intersected, and then proceed horizontally to the left vertical axis and read the value of V/V_o, in this case 0.58. Multiplying the initial visibility, 2.5 nmi, by 0.58 we arrive at the forecast visibility, namely, 1.5 nmi.

The applicability of this relationship is not limited to cases where fog eventually forms or to cases where relative humidities increase; the method can be used to forecast visibilities given decreasing relative humidities.

FORECAST RELATIVE HUMIDITY (%)
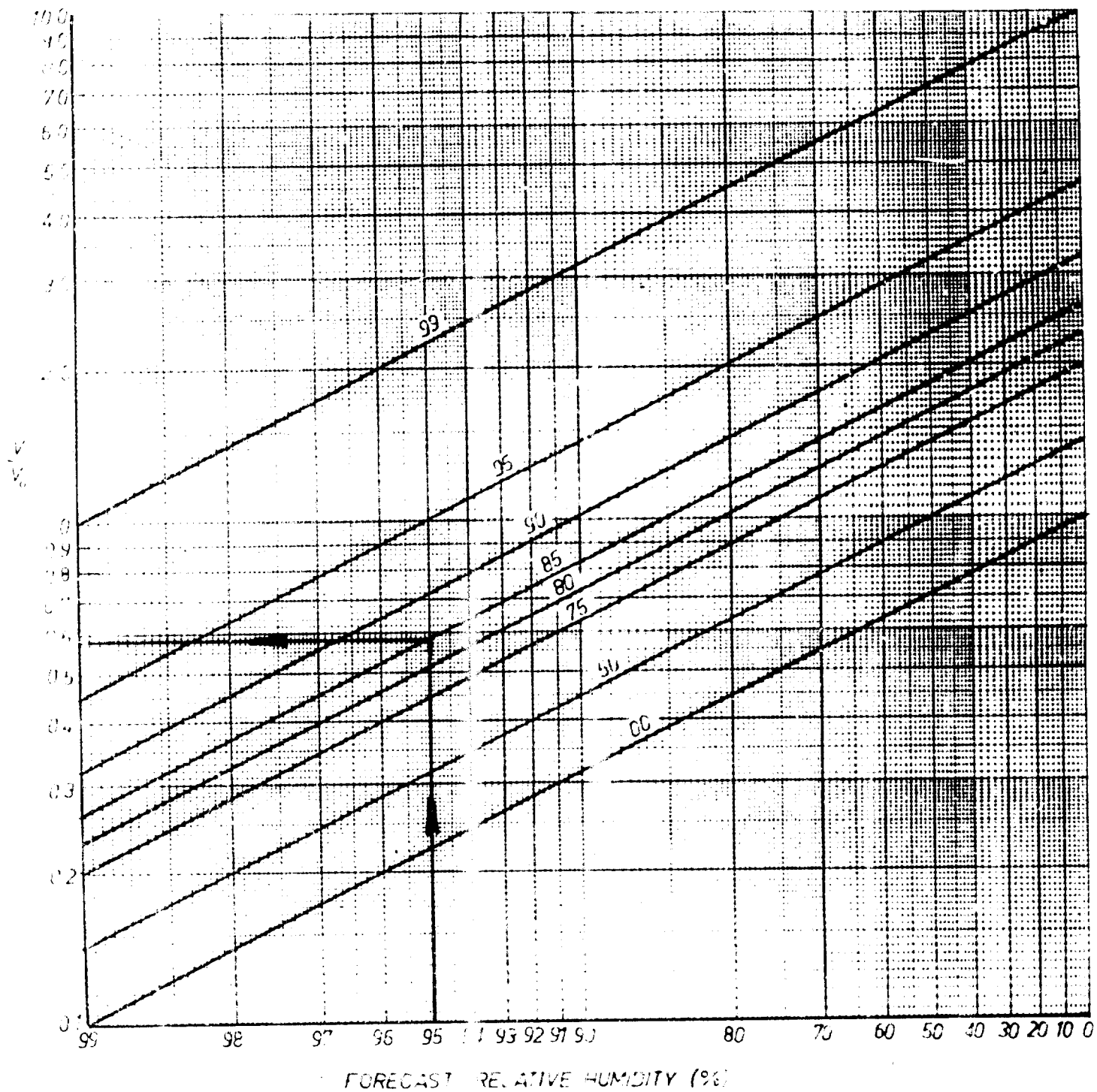
References

1. Kasten, F., "Visibility Forecast in the Phase of Pre-Condensation," *Tellus*, Vol 21, No 5, 1969, pp 631-635.

2. Winkler, i., "Das Wachstum von Aerosolteilchenproben in Abhängigheit von der relativen Feuchte," Mainz, Diplom-Thesis at The Faculty for Natural Sciences of the Johannes Gutenberg University. Partly to be published in *Annalon der Meteorologie*, Nove Folge No 4 (1969).

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13. ABSTRACT

The problem of forecasting low visibilities has become less a problem of forecasting restrictions owing to condensed water droplets but rather has become more a problem of forecasting low visibilities owing to suspended particles. This paper discusses a formula and graph to calculate forecast visibility given initial conditions of visibility and relative humidity.

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